

SHELL SEMS PROJECT

JANUARY - MARCH, 1985

Quarterly Report No. 2

Sandia National Laboratories
Geo Systems Division 6256
Dennis Engi, Supervisor
James Hickerson
Alonzo Lopez

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This is the second in a series of regular quarterly reports. SEMS is an acronym for Sandia Laboratories' Seafloor Earthquake Measurement System.

This report is the result of work performed under Funds-in-Agreements No. DE-FI04-83AL24280, between the Department of Energy and the SHELL Development Company. Supporting studies have been funded by the Minerals Management Service of the Department of Interior.

1.0 Current Status

Reference [1] describes work prior to this quarter. Reference [2] provides the terms of the DOE/SHELL agreement.

All parts for the SHELL SEMS have been received. The unit has been fully assembled and all mechanical parts have been given fit tests. Electronic components are completed and have been thermal cycled and functionally tested. The total assembly began immersion testing on April 1 in the 50 foot deep Sandia Test Pond facility. All critical electronic functions and seaworthiness will be checked during this three day test. If all results are satisfactory, then the unit will be prepared for shipment to Long Beach for installation on SHELL property in the Beta field.

A contract for deployment services, supporting hardware, vessels, and a submersible has been executed with GEOMAREX of La Jolla, California. Deployment is scheduled for the week of April 29 to May 3. The actual date will depend on the readiness of all parties and the local weather and sea conditions.

Preparations for deployment are being coordinated with SHELL California Production through Tom Szytel of the Bakersfield office. Notification of the operation has been given to the Coast Guard, Corps of Engineers, and the Minerals Management Service.

Estimates of the background noise due to all sources, both internal and external to SEMS has been accomplished. The sum from all sources is not expected to exceed 0.0001 gravity units on fair weather days, and not more than 0.001 gravity units during the worst storm conditions. This is well within the range of values necessary for proper system operation.

During the last quarter the Sandia Geotechnical Engineering Division 6252 was merged with the Geo Systems Division 6256. Dennis Engi (telephone AC 505/844-4831) now heads the SEMS projects being conducted at Sandia. All other staff and management above and below Engi remain the same.

2.0 Plans for Next Quarter

Final tests of SEMS will be completed by mid-April. We expect to have the final version of the operational software completed and checked out at the same time. The unit will then be shipped to Long Beach with an intended arrival date of April 25. We hope to make the installation of the unit on

April 29 or April 30, leaving the latter days in that week available for deployment should circumstances prevent us from conducting an earlier operation.

Once SEMS has been installed, we will be setting up a monitoring schedule as follows:

April	Verify the health of the unit after installation.
May	Monitor the unit on two week intervals to determine the operational characteristics and the background noise signature of the site.
June	Monitor the unit at least one more time. After that we expect to monitor the unit on three month intervals and after major seismic events.

3.0 Summary of Accomplishments

3.1 Hardware Assembly. After the arrival of all cable and connector assemblies in March it was possible to perform fit checks and assembly tests on all major pieces of hardware. These tests have been completed and the unit was fully assembled, except for operational battery packs and recovery float, for the immersion test. No major problems have been encountered and the unit appears to be mechanically ready for installation. Documentation of the design and assembly will be covered in an upcoming development report.

Calibration tests of the accelerometers were conducted during February and March. Low frequency calibration was performed on individual accelerometers over the frequency range of 0.05 to 2.0 Hz. Because the probe assembly could conceivably influence the accelerometer response at high frequency, a calibration of the fully assembled probe was conducted over the frequency range of 2 to 20 Hz. No probe resonances or interactions were found that would influence the calibration of the accelerometers over the high frequency range. Natural frequency of the assembled probe and accelerometer mount is in excess of 200 Hz, which is well above the frequency range of interest.

Final assembly of the probe was accomplished on March 28. Thirty seven grams of molecular sieve desiccant were added prior to the final sealing of the probe. Barring any water leakage by O-ring seals, internal humidity should remain below 45 per cent over the five year design life. Tests of all internal circuits and components after assembly indicated that all were working properly.

3.2 Immersion Test. On March 29 the assembly and preparations were completed for a five day immersion test of the unit in the Sandia Test Pond facility. The unit will be immersed beneath 45 feet of water and functionally tested during this period. This will involve communication with the unit via the acoustic telemetry system onboard SEMS and the shipboard Command and Recording system that will be used after installation. The following functions will be checked during the test:

- Operation of the SEMS telemetry system
- Operation of the shipboard Command and Recording System
- Operation of the SEMS command system software
- Functionality of the magnetometer hardware and software
- Functionality of the accelerometer hardware and software
- Functionality of the recovery float release system
- Seaworthiness of the connector and cable assemblies
- Seaworthiness of the pressure vessels
- Seaworthiness of the seismic probe

3.3 Contracts for Deployment. In January a contract was executed with GEOMAREX of La Jolla, California, to provide support for the deployment of the SHELL SEMS. GEOMAREX will modify its P4 vibrocorer to allow it to drill the insertion hole for the seismic probe and install a temporary hole casing. GEOMAREX will demonstrate the operation of this equipment in a series of tests and a dry run prior to the actual deployment operation. To date GEOMAREX has completed the necessary modifications to its equipment and is currently testing the individual functions of each item. A test of the drilling and casing assembly is scheduled to be performed from the deployment vessel on April 5.

GEOCUBIC of Ventura, California, has subcontracted with GEOMAREX to provide the services of its 147 foot research vessel, "Glorita", and its two man submersible, "Delta". GEOCUBIC will provide navigation, deck equipment, and necessary crews for the accomplishment of the installation. GEOMAREX will provide deck support and direct the installation based on requirements set by Sandia.

3.4 Coordination with SHELL California Production. On February 28, James Hickerson met with Tom Szytel, Senior Facilities Engineer with the Production Engineering Department of SHELL California. Plans were made for obtaining the necessary approvals for conducting operations on SHELL property in the Beta field and for defining an appropriate SEMS site.

From that meeting and subsequent telephone conversations the following understandings were reached:

- * Szytel will coordinate SHELL California activities.
- * Hickerson will coordinate the activities of Sandia and its contractors.
- * SHELL California will provide Sandia with maps of the area showing the locations of platforms, pipelines, cables, right-of-ways, boundaries, and acceptable SEMS locations.
- * Sandia would provide SHELL California with a description of its equipment and proposed operations.
- * SHELL California will provide written authorization for the deployment of SEMS prior to installation.
- * Sandia will obtain the necessary permits from the Corps of Engineers and will notify the Coast Guard and the Minerals Management Service of the nature and dates of the deployment.
- * SHELL California will consider providing an observer and navigational aids during the SEMS installation.

As of this writing Sandia has been informed that the formal approval package and necessary maps have been prepared and are being circulated to appropriate management at SHELL California. Appendices 1,2,and 3 are copies of the correspondence between Sandia and those governmental agencies identified above as being necessary to notify. Based on telephone conversations between Hickerson and Szytel, it appears that the site and dates chosen earlier will be satisfactory to both parties. The Corps of Engineers has also given verbal assurances that it would provide the necessary permit to allow the installation of the SHELL SEMS.

3.6 Estimates of Background Noise. A principal requirement for high quality seismic measurements is that the measuring equipment and the surrounding environment be free of electrical noise or mechanical vibrations that might mask incoming earthquake vibrations. For SEMS this is particularly true since our system is configured to trigger on seismic vibrations that exceed 1.5 times the background noise level. We would like that background level to be no more than the equivalent of 0.0015 gravity units (g).

There are three principal sources of background noise for a properly sited SEMS. These are noise inherent in the accelerometer internal circuits, noise inherent in the system electronics, and mechanical vibrations of the sediment due to ocean wave action. If the SEMS has been properly sited, then other contributions such as mechanical noise created by activities on nearby offshore structures should be negligible.

Based on past experience with our electronics and data from the supplier of the seismic accelerometers, we have predicted that purely electronic noise in the system would be limited to values that translate to less than 0.0001 gravity unit. Actual measurements of electronic background noise in the assembled system will be made after the immersion test is complete.

The third source of background noise, mechanical response created by waves passing overhead has been the subject of analytical work underway since October. Response of the sediment due to cyclic hydraulic loads from waves passing overhead has been calculated to be less than 0.00001 gravity units for all expected wave heights, provided that the waves are not breaking. Breaking waves, however, create seismic responses of the sediment that until now were impossible to predict. Fred Norwood of Sandia's Solid Dynamics Department has been studying this problem at our request under funding from the Minerals Management Service. Norwood has completed an analysis that now allows us to predict the upper bounds of sediment response due to the breaking of storm waves overhead SEMS [3,4]. Although this work was originally directed at the very severe environment of the Bering Sea, it can also be applied to the much milder sea states of southern California. Based on Norwood's work, it appears that we can summarize the background noise levels that the SHELL SEMS should measure as follows:

	<u>Non-Storm Conditions</u>	<u>Storm Conditions</u>
System Electronics	.000500 g	.00020 g
Hydraulic Noise from non-breaking waves	.000001 g	.00001 g
Breaking Wave Noise (worst case)	.000000 g	.01000 g
Total Background Noise	.000501 g	.01021 g

During calm conditions, or during storms in which the waves are not breaking offshore, we expect the background noise levels to be significantly less than 0.001 g. During the extremely rare cases when waves are breaking far offshore it appears possible that occasional background accelerations as high as 0.01 g could be measured. Based on our experience in the Santa Barbara Channel, we do not believe that these rare occurrences will hamper our ability to detect earthquakes or record high quality data.

4.0 References

1. Geotechnical Engineering Division 6252, "SHELL SEMS Project, October-December 1984, Quarterly Report No. 1", Sandia National Laboratories.
2. Agreement Between United States of America and SHELL Development Company, DE-FI04-83AL24280, February 6, 1984. Amendment No. 1, October 24, 1984.
3. F.R. Norwood, "Analytical Modelling of a Breaking Wave in an Acoustic-Elastic System", draft paper being prepared for journal publication.
4. F.R. Norwood, "CSEMS: A Computer Program for Calculating Sediment Accelerations Due to Breaking Waves", draft Sandia National Laboratories Report.

APPENDIX I

Letter to the Corps of Engineers

Sandia National Laboratories

Albuquerque, New Mexico 87185

March 21, 1985

**U.S. Army Corps of Engineers
PO Box 2711
Los Angeles, CA 90053-2325**

**Attn: Regulatory Branch
Dick Clark**

Dear Mr. Clark:

This letter will confirm the topics covered in our telephone discussion of March 18 and provide the information you requested for preparing a permit for our ocean bottom scientific instrument. The unit we wish to deploy is the Sandia Seafloor Earthquake Measurement System. It is being done under a joint agreement between the Department of Energy (our managing agency) and Shell Development Company. It will be used to measure and record earthquake data that will later be released to the offshore community for use in the design of drilling and production structures.

A. Description of the seafloor unit.

Sandia National Laboratories is providing its Seafloor Earthquake Measurement System for this project. The unit is a self-contained, remote seismic station designed to operate unattended for five years. It measures 6'x6'x2-1/2' high and weighs 1600 lbs. dry. It poses no known environmental hazards and is similar to 4 units installed and operated in the Santa Barbara Channel during 1979-1981. It will be monitored at 2-4 month intervals via an onboard acoustic telemetry system that can communicate with a receiver onboard an overhead surface vessel. It is designed to shed fishing nets and does not present an obstruction to surface or underwater activities of fishermen, mariners, or others. At the end of its projected 3-5 year life, it can be commanded to release a recovery float and line to allow it to be hoisted from the seafloor and recovered.

B. Deployment Operations

The deployment of the unit is currently planned for a time window of April 29 to May 3. The actual operation should require no more than 10 daylight hours. No vessels are

March 20, 1985

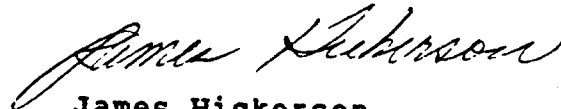
expected to remain at the site overnight. We have under contract GEOMAREX, Inc. of La Jolla, who in turn has contracted for vessel and submersible services from GEOCUBIC, Inc., of Ventura, California. GEOCUBIC will operate the 147-ft "GLORITA" out of Long Beach, and the two-man submersible, "DELTA." The GLORITA will be anchored over the deployment site during all operations.

C. Location

By agreement with Shell California Production, all operations will be confined to an area within an 800-foot radius of coordinates 521,914 N, 1,429,639 E, California Lambert Zone 6. This position also lies 2000 feet due NE of the center of the bridge connecting the ELLEN-ELLY platforms operated by Shell Production, and is further identified by LAT 33°35'13" N, LONG 118°07'~~32~~' W. This area is more than 500 meters from the nearest offshore platform ("ELLY"), and more than 200 meters from the nearest submarine cable or pipeline.

I trust that this information will be sufficient for your purposes. We will notify you of any changes in dates or operational plans.

Sincerely yours,



James Hickerson
GeoSystems Division 6256
(Telephone: 505 846-4518)

Encl: Map of SEMS Location

copies to:

Andre' Rossfelder, GEOMAREX w/encl

Tom Szytel, Shell California Production W/encl.

6256 D. Engi, w/encl

6256 A. A. Lopez, w/encl

APPENDIX II

Letters to the Coast Guard

Sandia National Laboratories

Albuquerque, New Mexico 87185

March 25, 1985

**11th Coast Guard District
OAN
400 Ocean Gate
Long Beach, CA 90822**

Attn: LCDR McDonough

Dear LCDR McDonough:

Please be advised that the longitudinal position of our SEMS deployment site was incorrectly stated in my letter to you of March 20. The correct position is:

**LAT 33°35'13" (unchanged)
LONG 118°07'22"**

The Lambert coordinates were stated correctly. I apologize for the error.

Sincerely yours,

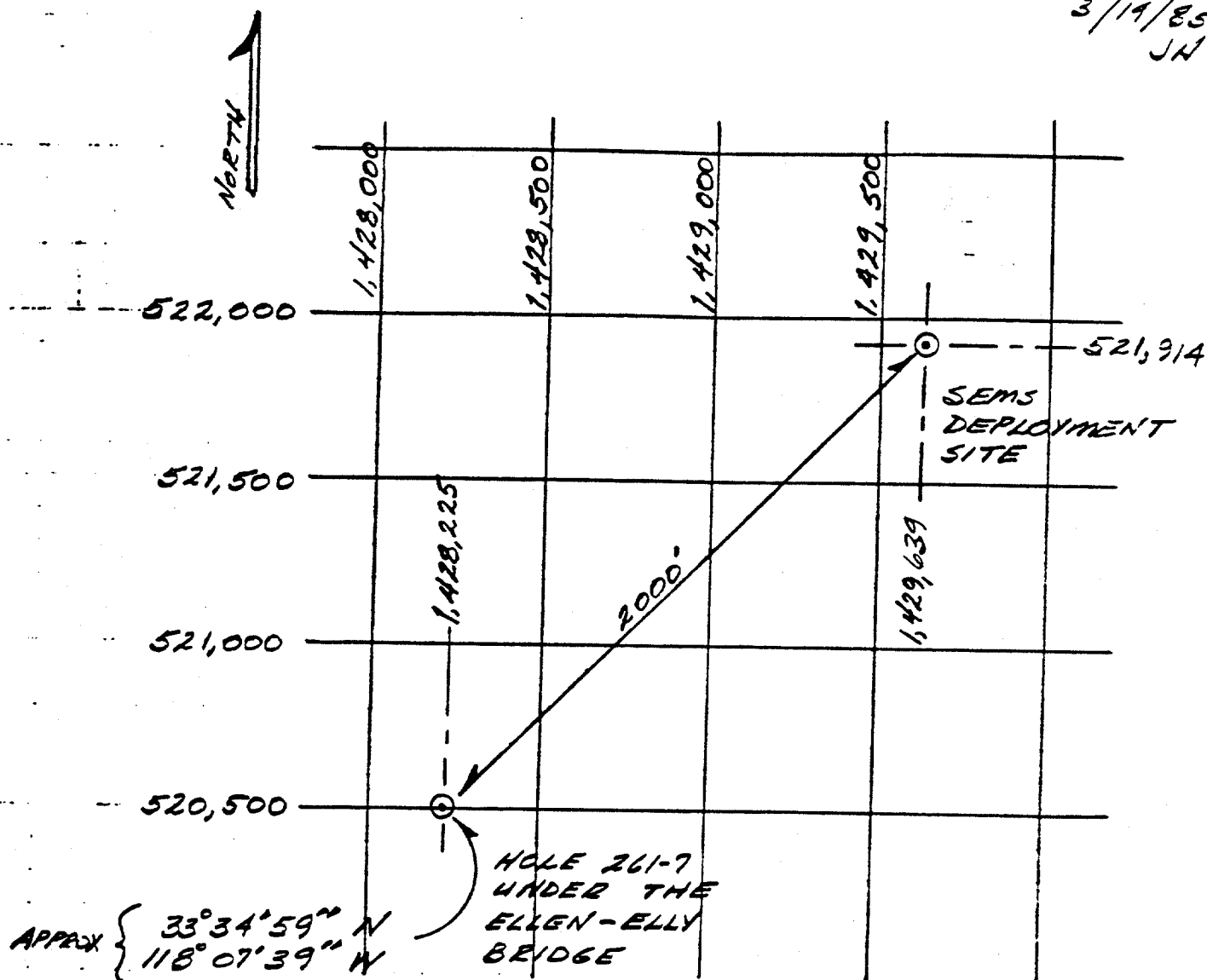


**James Hickerson
GeoSystems Division 6256**

JH:354:3

**copy to:
U.S. Army Corps. of Engineers
Attn: Regulatory Branch, Dick Clark
Tom Szytel, Shell California Production
Andre Rossfelder, Geomarex
6256 A. A. Lopez**

3/14/85
JH



CONVERSION FACTORS:

101.1 FT/SEC LAT.
84.8 FT/SEC LONG.

SEMS LAT/LONG.:

$$\begin{aligned} \text{LAT: } 33^{\circ}34'59'' + \frac{(2000 \text{ FT}) \sin 45^{\circ}}{101.1 \text{ FT/SEC}} &= 33^{\circ}34'59'' + 14'' \\ &= \underline{33^{\circ}35'13''} \end{aligned}$$

$$\begin{aligned} \text{LONG: } 118^{\circ}07'39'' - \frac{(2000 \text{ FT}) \cos 45^{\circ}}{84.8 \text{ FT/SEC}} &= 118^{\circ}07'39'' - 17'' \\ &= \underline{118^{\circ}07'22''} \end{aligned}$$

Sandia National Laboratories

Albuquerque, New Mexico 87185

March 20, 1985

11th Coast Guard District

OAN

400 Ocean Gate

Long Beach, CA 90822

Attn: LCDR McDonough

Dear LCDR McDonough:

On March 18 I spoke by telephone with CDR Skip Onstad of your office. We discussed the plans being made by my laboratory and Shell California Production, Inc., to deploy an earthquake measurement station on the seafloor in the Beta Field. CDR Onstad requested that I notify you of the details of this operation so that you can issue the necessary notices to mariners.

A. Description of the seafloor unit.

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I trust that this information will be sufficient for your purposes. We will notify you of any changes in dates or operational plans.

Sincerely yours,

James Hickerson

James Hickerson
GeoSystems Division 6256
(Telephone: 505 846-4518)

Encl: Map of SEMS Location

copies to:

Andre' Rossfelder, GEOMAREX w/encl

Tom Szytel, Shell California Production W/encl.

6256 D. Engi, w/encl

6256 A. A. Lopez, w/encl

APPENDIX III

Letter to the Minerals Management Service

Sandia National Laboratories
Albuquerque, New Mexico 87185

March 25, 1985


Julia Van Auker
Minerals Management Service
Department of Interior
1340 West 6th
Los Angeles, CA 90017

Dear Julia:

Enclosed is the brief background material you requested that describes our Seafloor Earthquake Measurement System. We currently plan to deploy this unit at the end of April in the Beta Field off Long Beach. We can probably accommodate an observer from your organization, provided Shell agrees.

I will be in touch with you later concerning the date of the installation.

Sincerely yours,


James Hickerson
Geo Systems Engineering
Division 6256

Encl: Background Information, 3/1/85

Distribution

SHELL Development Company
Production Operations Research Department
PO Box 481
Houston, TX 77001

Attn: Dr. Ravi Kinra (2)
Dr. Raul Husid (3)

Mr. Charles Smith
Minerals Management Service
Technology Assessment and Research Branch
647 National Center
Reston, VA 22091

Mr. Harold Shoemaker
US Department of Energy
Morgantown Energy Technology Center
PO Box 880 Collins Ferry Road
Morgantown, WV 26505

Mr. A. Hartstein
US Department of Energy
FE-32 D-132 GTN
Washington, DC 20545

Attn: Mr. Edward Ferrerri

1533	P. Yarrington
1533	F. Norwood
6200	V.L. Dugan
6250	B.W. Marshall
6256	D. Engi (2)
6256	A.A. Lopez
6256	C.A. Longfellow
6256	J.P. Hickerson (5)